L Number	Hits	Search Text	DB	Time stamp
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1	☐	☐	US 6301594 B1	20011009	10
2	☒	☐	US 6185593 B1	20010206	17
3	☒	☐	US 6175847 B1	20010116	16
4	☒	☐	US 6173299 B1	20010109	17
5	☒	☐	US 5963461 A	19991005	22
6	☒	☐	US 5764549 A	19980609	9
7	☒	☐	US 5570309 A	19961029	26
8	☒	☐	US 5487022 A	19960123	34
9	☒	☐	US 5276634 A	19940104	72
10	☒	☐	US 5109417 A	19920428	50
11	☒	☐	US 5027308 A	19910625	17

	Title	Current OR	Current XRef
1	Method and apparatus for high-speed exponent adjustment and exception generation for normalization of floating-point numbers	708/205	708/495; 708/505
2	Method and apparatus for parallel normalization and rounding technique for floating point arithmetic operations	708/205	708/497
3	Shifting for parallel normalization and rounding technique for floating point arithmetic operations	708/205	708/497
4	Method and apparatus for selecting an intermediate result for parallel normalization and rounding technique for floating point arithmetic operations	708/205	708/497
5	Multiplication apparatus and methods which generate a shift amount by which the product of the significands is shifted for normalization or denormalization	708/503	708/205; 708/209; 708/505; 708/507; 708/508; 708/521; 708/524; 712/34; 712/42
6	Fast floating point result alignment apparatus	708/205	
7	Iterative arithmetic processor	708/493	708/205
8	Normalization method for floating point numbers	708/205	708/495
9	Floating point data processing apparatus which simultaneously effects summation and rounding computations	708/497	708/205; 708/503; 708/504; 708/505
10	Low bit rate transform coder, decoder, and encoder/decoder for high-quality audio	704/205	375/240; 704/203; 704/224; 704/229; 704/500; 708/205; 708/495
11	Circuit for adding/subtracting two floating point operands	708/505	708/205; 708/496

	Retrieval Classif	Inventor	S	C	P	2	3	4	5
1		Ahmed, Sadar U.	☒	☐	☐	☐	☐	☐	☐
2		Brooks, Jeffrey S. et al.	☐	☐	☐	☐	☐	☐	☐
3		Brooks, Jeffrey S. et al.	☐	☐	☐	☐	☐	☐	☐
4		Brooks, Jeffrey S. et al.	☐	☐	☐	☐	☐	☐	☐
5		Gorshtein, Valery Y. et al.	☐	☐	☐	☐	☐	☐	☐
6		Bjorksten, Andrew A. et al.	☐	☐	☐	☐	☐	☐	☐
7		Miyoshi, Akira et al.	☐	☐	☐	☐	☐	☐	☐
8		Simpson, Richard et al.	☐	☐	☐	☐	☐	☐	☐
9		Suzuki, Masato et al.	☐	☐	☐	☐	☐	☐	☐
10		Fielder, Louis D. et al.	☐	☐	☐	☐	☐	☐	☐
11		Sit, Hon P. et al.	☐	☐	☐	☐	☐	☐	☐

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1	US 6301594	☐
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3	US 6175847	☐
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5	US 5963461	☐
6	US 5764549	☐
7	US 5570309	☐
8	US 5487022	☐
9	US 5276634	☐
10	US 5109417	☐
11	US 5027308	☐

	U	1	Document ID	Issue Date	Pages
12	☒	☐	US 4941120 A	19900710	11
13	☒	☐	US 4926370 A	19900515	10
14	☒	☐	US 4926369 A	19900515	18
15	☒	☐	US 4905178 A	19900227	8
16	☒	☐	US 4779220 A	19881018	6

	Title	Current OR	Current XRef
12	Floating point normalization and rounding prediction circuit	708/497	708/205
13	Method and apparatus for processing postnormalization and rounding in parallel	708/497	708/205
14	Leading 0/1 anticipator (LZA)	708/505	708/205; 708/211
15	Fast shifter method and structure	708/209	708/205
16	Floating-point data rounding and normalizing circuit	708/497	708/205; 708/235; 708/498

	Retrieval Classif	Inventor	S	C	P	2	3	4	5
12		Brown, Jeffrey D. et al.	☐	☐	☐	☐	☐	☐	☐
13		Brown, Jeffrey D. et al.	☐	☐	☐	☐	☐	☐	☐
14		Hokenek, Erdem et al.	☐	☐	☐	☐	☐	☐	☐
15		Mor, Yeshayahu et al.	☐	☐	☐	☐	☐	☐	☐
16		Nukiyama, Tomoji	☐	☐	☐	☐	☐	☐	☐

	Image Doc. Displayed	PT
12	US 4941120	☐
13	US 4926370	☐
14	US 4926369	☐
15	US 4905178	☐
16	US 4779220	☐

	U	1	Document ID	Issue Date	Pages
1	☐	☐	US 6268875 B1	20010731	23
2	☒	☐	US 6229553 B1	20010508	23
3	☒	☐	US 5933808 A	19990803	25
4	☒	☐	US 5491775 A	19960213	19

	Title	Current OR	Current XRef
1	Deferred shading graphics pipeline processor	345/506	345/422
2	Deferred shading graphics pipeline processor	345/506	345/419; 345/426; 345/582; 345/584
3	Method and apparatus for generating modified speech from pitch-synchronous segmented speech waveforms	704/278	704/207; 704/218; 704/241
4	Microcontroller fuzzy logic processing module using selectable membership function shapes	706/4	706/52; 706/900

	Retrieval Classif	Inventor	S	C	P	2	3	4	5
1		Duluk, Jr., Jerome F. et al.	☒	☐	☐	☐	☐	☐	☐
2		Duluk, Jr., Jerome F. et al.	☐	☐	☐	☐	☐	☐	☐
3		Kang, George S. et al.	☐	☐	☐	☐	☐	☐	☐
4		Madau, Dinu P. et al.	☐	☐	☐	☐	☐	☐	☐

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2	US 6229553	☐
3	US 5933808	☐
4	US 5491775	☐

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5	71	708/205.ccls. and (normaliz$5) same (grid point) same (large value)	USPAT	2002/02/20 13:20
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7	755	708/?.ccls.	USPAT	2002/02/20 13:58
8	56	708/?.ccls. and (normaliz$6)	USPAT	2002/02/20 13:58
9	0	708/?.ccls. and (normaliz$6) same (integer)	USPAT	2002/02/20 13:59
10	0	708/?.ccls. and (normaliz$6) same (interpolation)	USPAT	2002/02/20 13:59
11	5	708/?.ccls. and (normaliz$6) and (interpolation)	USPAT	2002/02/20 14:00
12	52	708/?.ccls. and (normaliz$6) and (data conversion)	USPAT	2002/02/20 14:01
13	42	708/?.ccls. and (normaliz$6) and (data conversion) and (look-up table or lut or look up table)	USPAT	2002/02/20 14:02
14	33	708/?.ccls. and (normaliz$6) and (data conversion) and (look-up table or lut or look up table) and (grid point)	USPAT	2002/02/20 14:09
15	1295	(normaliz$6) same (integer$1)	USPAT	2002/02/20 14:09
16	85	(normaliz$6) same (integer$1) same (data conversion) same (look-up table or lut or look up table)	USPAT	2002/02/20 14:10
17	4	(normaliz$6) same (integer$1) same (data conversion) same (look-up table or lut or look up table) same (interpolation)	USPAT	2002/02/20 14:10

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1	☐	☐	US 4649506 A	19870310	16
2	☐	☐	US 4559605 A	19851217	22
3	☐	☐	US 4156916 A	19790529	18
4	☐	☐	US 4061904 A	19771206	46
5	☐	☐	US 3831016 A	19740820	20

	Title	Current OR	Current XRef
1	Vector generator using interpolative analog circuits	708/8	315/367; 345/12; 345/24; 345/443
2	Method and apparatus for random array beamforming	708/403	250/265; 367/122; 367/138; 367/5; 708/404; 708/5
3	Pulse burst processing system and apparatus	708/3	327/126; 327/355; 327/68; 341/126; 341/130; 341/144; 341/157; 708/8
4	Variable analog function generator	708/9	708/846
5	FUNCTION INTERPOLATOR	708/8	708/847; 708/852

	Retrieval Classif	Inventor	S	C	P	2	3	4	5
1		Van den Heuvel, Raymond C.	☒	☐	☐	☐	☐	☐	☐
2		Norsworthy, Keith	☒	☐	☐	☐	☐	☐	☐
3		Poppelbaum, Wolfgang J.	☒	☐	☐	☐	☐	☐	☐
4		Hannauer, George et al.	☒	☐	☐	☐	☐	☐	☐
5		Nathan, Amos	☒	☐	☐	☐	☐	☐	☐

	Image Doc. Displayed	PT
1	US 4649506	☐
2	US 4559605	☐
3	US 4156916	☐
4	US 4061904	☐
5	US 3831016	☐

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1	3	(("5715336") or ("5764549") or ("5926296")).PN.	USPAT	2002/02/20 14:24
2	2	(("6268875") or ("6219682")).PN.	USPAT	2002/02/20 14:27
3	119	balasubramanian.in.	USPAT	2002/02/20 14:28
4	6	balasubramanian.in. and (normaliz$6)	USPAT	2002/02/20 14:28

	U	1	Document ID	Issue Date	Pages
1	☐	☐	US 6342951 B1	20020129	10
2	☐	☐	US 6295137 B1	20010925	9
3	☐	☐	US 6285462 B1	20010904	13
4	☐	☐	US 5739927 A	19980414	10
5	☐	☐	US 4158503 A	19790619	10
6	☐	☐	US 4140921 A	19790220	5

	Title	Current OR	Current XRef
1	Gamut mapping algorithm using inverted gamma function	358/1.9	358/519
2	Method of color correction using multi-level halftoning	358/1.9	358/456; 358/518; 358/523; 358/534
3	Intelligent GCR/UCR process to reduce multiple colorant moire in color printing	358/1.9	358/533
4	Method for refining an existing printer calibration using a small number of measurements	358/518	358/523
5	Heterodyne optical correlator	356/71	356/390; 359/561
6	Generalized performance power optimized PLA circuits	326/44	326/83; 365/104; 365/194; 708/232

	Retrieval Classif	Inventor	S	C	P	2	3	4	5
1		Eschbach, Reiner et al.	☒	☐	☐	☐	☐	☐	☐
2		Balasubramanian, Thyagarajan	☒	☐	☐	☐	☐	☐	☐
3		Balasubramanian, Thyagarajan et al.	☒	☐	☐	☐	☐	☐	☐
4		Balasubramanian, Thyagarajan et al.	☒	☐	☐	☐	☐	☐	☐
5		Balasubramanian, N.	☒	☐	☐	☐	☐	☐	☐
6		Balasubramanian, Peruvemba S. et al.	☒	☐	☐	☐	☐	☐	☐

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1	US 6342951	☐
2	US 6295137	☐
3	US 6285462	☐
4	US 5739927	☐
5	US 4158503	☐
6	US 4140921	☐

Integrals

History of the Integral

Integral calculus originated with quadrature and cubature problems. To solve a *quadrature* problem means to find the exact value of the area of a two-dimensional region whose boundary consists of one or more curve(s), or of a three-dimensional surface, again whose boundary consists of at least one curve. For a *cubature* problem, we want to determine the exact volume of a three-dimensional solid bounded at least in part by curved surfaces. Today, the use of the term *quadrature* hasn't changed much: mathematicians, scientists, and engineers commonly say that they have "reduced a problem to a quadrature," and mean that they have taken a complicated problem, simplified it by various means, and now the problem can be solve by evaluating an integral.

Historically, Hippocrates of Chios (ca. 440 B.C.) performed the first quadratures when he found the areas of certain *lunes*, regions that resemble the moon at about its first quarter. Antiphon (ca. 430 B.C.) claimed that he could "square the circle" (i.e. find the area of a circle) with an infinite sequence of inscribed regular polygons: first, a square; second, an octagon; next, a 16-gon; etc., etc. His problem was the "etc., etc.." Because Antiphon's quadrature of the circle required an infinite number of polygons, it could never be finished. He would have had to use the modern concept of the *limit* to produce a rigorous mathematical completion of this process. But Antiphon did have the start of a major idea, now called the *method of exhaustion*. More than 2000 years later, we credit Eudoxus (ca. 370 B.C.) with the development of the method of exhaustion: a technique of approximating the area of a region with an ever increasing number of polygons, with the approximations improving at each step and the exact area being attained after an infinite number of these steps; this technique has been modified to attack cubatures also.

Archimedes (287--212 B.C.), the greatest mathematician of antiquity, used the method of exhaustion to find the quadrature of the parabola. Archimedes approximated the area with a large number of ingeniously constructed triangles and then used a double *reductio ad absurdum* argument to prove the result rigorously and avoid any of the metaphysics of the infinite. For the circle, Archimedes first showed that the area depends upon the circumference; this is very easy for us to verify today, since both formulas depend on π. Then, Archimedes approximated the area of the circle of unit radius using both inscribed and circumscribed regular 96-gons! His famous result was $3\ 10/71 < \pi < 3\ 1/7$; but as these were only approximations, in the strict sense, they were not quadratures. This technique refined the method of exhaustion, so that when there are an infinite number of polygonal approximations, it is called the *method of compression*. Archimedes' process for finding the area of a segment of a spiral was to compress this region between sectors of inscribed and circumscribed circles: his method of determining the volume of a conoid (a solid formed by revolving a parabola around its axis) was to compress this solid between inscribed and circumscribed cylinders. In each case, the final step that rigorously established the result was a double *reductio ad absurdum* argument.

In perhaps his most famous work of all, a tract combining mathematics and physics, Archimedes employed *indivisibles* to estimate the center of gravity of certain two-dimensional regions and three-dimensional solids. (Archimedes acknowledged that while this work very strongly suggested the truth of his results, it also lacked full logical rigor.) If we consider one of these regions to be composed of an infinite number of straight lines, of varying lengths, then these lines are called *indivisibles*. Similarly, when the composition of a three-dimensional solid is thought of as an infinite number of circular *disks*, of varying radii but with zero thickness, then these disks are known as *indivisibles*.

Muslim mathematicians of the 9th through the 13th centuries were great students of Archimedes, but they never knew about Archimedes' determination of the volume of a conoid. So, one of the most notable of all Arabic mathematicians, Thabit ibn Qurrah (826--901) devised his own rather complicated cubature of this solid, and then the Persian scientist Abu Sahl al-Kuhi (10th century) considerably simplified Thabit's process. Ibn al-Haytham (965--1039), known in the West as Alhazen and famous for his work in optics, used the method of compression to find the volume of the solid formed by rotating the parabola around a line perpendicular to the axis of the curve.

During medieval times in the West, progress was made in applying the ideas of calculus to problems of motion. William Heytesbury (fl. 1335), a member of the notable group of scholars at Merton College, Oxford, first devised methods for the determination of the velocity and then the distance traveled of a body that was assumed to be in "uniform acceleration." Today, we can achieve these results by finding two *indefinite integrals*, or *antiderivatives*, in succession. News of this work of Heytesbury and his Merton colleagues reached Paris later in the 14th century where Nicole Oresme (1320--1382) represented both velocities and times as line segments of varying lengths. Oresme packed a body's velocity lines together vertically, much like Archimedes' indivisibles, over a horizontal base line, and the whole *configuration*, as he called it, represented the total distance covered by the body. In particular, the *area* of this configuration was called the "total quantity of motion" of the body. Here we have precursors to modern graphs, and the birth of kinematics.

As Europeans began seriously to explore the globe, they wished to have a map of the world on which certain straight lines would represent the *rhumb lines* on the earth's surface. There have been several solutions to this problem, but the most famous solution was the Mercator projection, even though Gerard Mercator (1512--1594) did not explain its geometric principles. That task was taken up by Edward Wright (1561--1615) who, in addition, provided a table that showed that distances along rhumb lines would be closely approximated by summing the products ($\sec \phi \Delta \phi$), where ϕ is the latitude; i.e., by approximating the integral of $\sec \phi$.

In his *New Stereometry of Wine Barrels* (1615), the famous astronomer Johannes Kepler (1571--1630) approximated the volumes of many three-dimensional solids, each of which was formed by revolving a two-dimensional region around an axis line. For each of these volumes of revolution, he subdivided the solid into many very thin slabs or disks called *infinitesimals* (note the difference between infinitesimals and Archimedes' indivisibles). Then, in each case, the sum of these infinitesimals approximated the desired volume. Kepler's Second Law of Planetary Motion required quadratures of segments of an ellipse, and to approximate these areas, he summed up infinitesimal triangles.

Bonaventura Cavalieri (1598--1647), a student of Galileo, developed a whole theory of indivisibles. For a two-dimensional region, Cavalieri considered the collection of "all the lines" to be a single number, the area of the region. Christiaan Huygens (1629--1695) criticized, "As to Cavalierian methods: one deceives oneself if one accepts their use as a demonstration but they are useful as a means of discovery preceding a demonstration ...that is what comes first...." Evangelista Torricelli (1608--1648), another disciple of Galileo and a friend of Cavalieri, attempted to reconcile some of the difficulties with indivisibles by asserting that lines could have some sort of thickness. He was careful to use *reductio ad absurdum* arguments to prove quadratures he obtained by indivisibles. "Gabriel's Horn" is an "incredible" cubature that Torricelli discovered.

Pierre Fermat (1601--1665) devised a technique for finding the areas under each of the "higher parabolas" ($y = kx^n$, where $k > 0$ is constant and $n = 2, 3, 4, \ldots$) using narrow inscribed and circumscribed rectangles to lead to the method of compression. Then he employed a geometric series to do the same for each of the curves $y = kx^n$, for $n = -2, -3, -4, \ldots$. But, to his disappointment, he was never able to extend these processes to the "higher hyperbolas", $y^m = kx^n$. By the 1640s, the general formula for the integral of the higher parabolas was known to Fermat, Blaise Pascal (1623-1662), Gilles Personne de Roberval (1602--1675), René Descartes (1596--1650), Torricelli, Marin Mersenne (1588--1648), and probably others.

John Wallis (1616--1703) was strongly committed to the relatively new algebraic notation, whose development was such a feature of 17th century mathematics. For instance, he treated the parabola, ellipse, and hyperbola as plane curves defined by equations in two variables rather than as sections of a cone. He also invented the symbol ∞ for infinity and, in using it, obscured places where we now know he should have used the limit. He extended the quadrature formula for $y = kx^n$ to the cases when n was a positive rational number by using indivisibles, clever ratios, and appeals to reasoning by analogy. Wallis' dependence on formulas led him to a number of interesting quadratures.

Roberval exploited Cavalieri's Principle to find the area under one arc of the cycloid. Roberval and Pascal were the first to graph the sine and cosine functions and to find the quadratures of these curves (for the first quadrant). Pascal approximated double and triple integrals using triangular and pyramidal sums. But these were not cubatures, rather they were steps in his effort to calculate the moments of certain solids for each of which he then determined the center of gravity.

Finally, Gregory St. Vincent (1584--1667) determined the area under the hyperbola, $xy = 1$, by using narrow inscribed and circumscribed rectangles of specially designed unequal widths and the method of compression. St. Vincent extended this and other quadratures to find many cubatures. Very shortly thereafter, his student, Alfonso Antonio de Sarasa (1618--1667) recognized that the quadrature of the hyperbola is closely connected to the product property of the logarithm!

Following a suggestion of Wallis, in 1657, William Neile (1637--1670) determined the length of an arbitrary section of the semi-cubical parabola, $y^2 = x^3$, and in 1658, Christopher Wren (1632--1723), the famous architect, found the length of one arch of the cycloid. In 1659, Hendrick van Heuraet (1634--ca.1660) generalized this work by summing infinitesimal tangents to a curve, thereby deriving the essence of our modern

method of *rectification* – using an integral to find the length of an arc.

In geometric form, much of the calculus of the first two-thirds of the 17th century culminated in *The Geometrical Lectures* (1670) of Isaac Barrow (1630--1677). Barrow relinquished his position as Lucasian Professor at Cambridge in favor of his former student, Isaac Newton (1642--1727). Newton followed James Gregory (1638--1675) in thinking of the area of the region between a curve and the horizontal axis as a variable; the left end of the region was fixed, but the right end was allowed to vary. This device allowed him to extend some of Wallis' quadrature formulas and it led him to the Fundamental Theorem of Calculus. Newton's last work on calculus, and also the first to be published, was his essay, "On the Quadrature of Curves," written during 1691--1693 and published as an appendix in the 1704 edition of his *Opticks*. Here he constructed an extensive table of integrals of rather complicated algebraic functions, and for curves for which he could not derive integration formulas, he devised geometric techniques of quadrature. Using the Fundamental Theorem of Calculus, Newton developed the basic techniques of evaluating integrals used today, including the method of substitution and integration by parts.

To Gottfried Wilhelm Leibniz (1646--1716), a curve was a polygon with an infinite number of sides. Leibniz (1686) let *y* represent an ordinate of the curve and *dx* the infinitesimal distance from one ordinate to the next, i.e., the difference between "successive" abscissae. Then he said, "I represent the area of a figure by the sum of all the [infinitesimal] rectangles contained by the ordinates and the differences of the abscissae ... and thus I represent in my calculus the area of the figure by $\int y\,dx$." Leibniz took the elongated "S" for the integral from the Latin *summa* and the *d* from the Latin *differentia,* and these have remained our most basic calculus notations ever since. He considered calculus computations to be a means of somehow abbreviating the classical Greek method of exhaustion. Leibniz was ambivalent about infinitesimals, but he believed that formal calculus computations could be trusted because they yielded correct results.

The term *integral*, as we use it in calculus, was coined by Johann Bernoulli (1667--1748) and first published by his elder brother Jakob Bernoulli (1654--1705). Mainly as a consequence of the power of Newton's and Leibniz's Fundamental Theorem of Calculus, integrals were simply regarded as "reverse" derivatives. Area was an intuitive notion, quadratures that could not be found using the Fundamental Theorem of Calculus were approximated. Even though Newton had made a very imperfect stab at the idea of a limit, no one in the 17th or 18th centuries had the foresight to combine limits and areas to define the integral mathematically. Instead, with great ingenuity, many clever integration formulas were developed. At about the same time as Newton's table of integrals was published, Johann Bernoulli devised systematic procedures for integrating all rational functions, what we now call the method of *partial fractions*. These rules were neatly summarized in Leonhard Euler's (1707--1783) encyclopedic three-volume work on integral calculus (1768--1770). Incidently, these efforts stimulated increased interest during the 18th century in factoring and solving higher degree polynomial equations.

While describing the paths of comets in the *Principia Mathematica* (1687), Newton posed a problem with major implications for calculus: "To find a curved line of the parabolic kind [i.e., a polynomial] which shall pass through any given number of points." Newton rediscovered the interpolation formula of James Gregory (1638--1675); today, it is called the Gregory-Newton formula, and in 1711, he pointed out its importance: "Hence the areas of all curves may be nearly found ... the area of the parabola [polynomial] will be

nearly the same with the area of the curvilinear figure ... the parabola [polynomial] can always be squared geometrically by methods generally known [i.e., by using the Fundamental Theorem of Calculus]." Newton's interpolation work was extended at various times by Roger Cotes (1682--1716), James Stirling (1692--1770), Colin Maclaurin (1698--1746), Leonhard Euler, and others. In 1743, the self-educated mathematician Thomas Simpson (1710-1761) found what has become a popular and useful special case of the Newton-Cotes formula for approximating an integral, *Simpson's Rule*.

Though Euler had made calculus more analytic than geometric with his emphasis on functions (1748; 1755; 1768), there were many misunderstandings about the function concept itself in the 18th century. Certain physics problems, such as the *vibrating string problem,* contributed to this confusion. Euler so closely identified functions with analytic expressions that he thought of a continuous function as being defined by only one formula for its whole domain. The modern idea of a *continuous function*, independent of any formula(s), was initiated in 1791 by Louis-François Arbogast (1759--1803): "The law of continuity consists in that a quantity cannot pass from one state [value] to another [value] without passing through all the intermediate states [values] ...." This insight was made rigorous in an 1817 pamphlet by Bernhard Bolzano (1781--1848) and is now know as the *Intermediate Value Theorem*. Discontinuous functions (in the modern sense) were forced onto the mathematical and scientific community by Joseph Fourier (1768--1830) in his famous *Analytical Theory of Heat* (1822).

When Augustin Louis Cauchy (1789--1857) undertook the total reform of calculus for his engineering students at the École polytechnique in the 1820s, the integral was one of his cornerstones:

> In the integral calculus, it has appeared to me necessary to demonstrate generally the existence of the *integrals* or *primitive functions* before making known their diverse properties. In order to attain this object, it was found necessary to establish at the outset the notion of *integrals taken between given limits* or *definite integrals*.

Cauchy defined the *integral* of any continuous function on the interval [*a*,*b*] to be the limit of the sums of areas of thin rectangles. His first obligation was to prove that this limit existed for all functions continuous on the given interval. Unfortunately, though Cauchy made use of the Intermediate Value Theorem, he failed in this task because he overlooked two subtle but crucial theoretical facts. He was not aware of these logical gaps in his reasoning, and he went on to justify the Mean Value Theorem for Integrals and to prove the Fundamental Theorem of Calculus for continuous functions. Niels Henrik Abel (1802--1829) also pointed out certain delicate errors when using Cauchy's integral to integrate every term of an infinite series of functions.

The first rigorous proof of the convergence of general Fourier series was devised by Peter Gustav Lejeune Dirichlet (1805--1859) in 1829. Dirichlet is also responsible for the modern definition of *function* (1837). In 1855, Dirichlet succeeded Carl Friedrich Gauss (1777-1855) as professor at the University of Göttingen. In turn, Georg F. B. Riemann (1826--1866) succeeded Dirichlet's (1859) at Göttingen. In the process of extending Dirichlet's work on Fourier series, Riemann generalized Cauchy's definition of the integral to arbitrary functions on the interval [*a*,*b*], and the limit of *Riemann sums* is the formulation in the text. Immediately, Riemann asked, "in what cases is a function integrable?" Most of Cauchy's development of the theory of integration was subsequently verified by

Riemann and others, but there were still difficulties with integrals and infinite series that were not worked out until the early years of the 20^{th} century.

Back Home Next

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Help | Logout | Interrupt

Main Menu | Search Form | Posting Counts | Show S Numbers | Edit S Numbers | Preferences | Cases

Search Results -

Terms	Documents
L2 and (normaliz$6) and (tetrahedral or tetrahedron)	7

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L6	L2 and (normaliz$6) same (data conversion)	0	L6
L5	L2 and (normaliz$6) same (grid point$1)	0	L5
L4	L2 and (normaliz$6) same (tetrahedron or tetrahedral)	0	L4
L3	L2 and normaliz$6	334	L3
L2	l1 and @pd<19980702	14689	L2
	DB=TDBD,PGPB,USPT; PLUR=YES; OP=ADJ		
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☐ 1. Document ID: US 5739927 A
File: USPT
Apr 14, 1998
L7: Entry 1 of 7

US-PAT-NO: 5739927
DOCUMENT-IDENTIFIER: US 5739927 A

TITLE: Method for refining an existing printer calibration using a small number of measurements

DATE-ISSUED: April 14, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Balasubramanian; Thyagarajan	Webster	NY		
Maltz; Martin Sidney	Rochester	NY		

US-CL-CURRENT: 358/518; 358/523

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

☐ 2. Document ID: US 5734802 A
File: USPT
Mar 31, 1998
L7: Entry 2 of 7

US-PAT-NO: 5734802
DOCUMENT-IDENTIFIER: US 5734802 A

TITLE: Blended look-up table for printing images with both pictorial and graphical elements

DATE-ISSUED: March 31, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Maltz; Martin S.	Rochester	NY		
Harrington; Steven J.	Fairport	NY		
Bennett; Scott A.	Rochester	NY		

US-CL-CURRENT: 358/1.9; 358/1.15, 358/1.2, 358/462, 358/515, 358/518, 358/520

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

☐ 3. Document ID: US 5724442 A

L7: Entry 3 of 7 File: USPT Mar 3, 1998

US-PAT-NO: 5724442
DOCUMENT-IDENTIFIER: US 5724442 A

TITLE: Apparatus for processing input color image data to generate output color image data within an output color reproduction range

DATE-ISSUED: March 3, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Ogatsu; Hitoshi	Kanagawa			JPX
Kita; Shinji	Kanagawa			JPX

US-CL-CURRENT: 382/167; 358/518, 358/520, 358/523, 382/162, 382/166

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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☐ 4. Document ID: US 5461580 A

L7: Entry 4 of 7 File: USPT Oct 24, 1995

US-PAT-NO: 5461580
DOCUMENT-IDENTIFIER: US 5461580 A

TITLE: Computer-aided chemical illustration system

DATE-ISSUED: October 24, 1995

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Facci; John S.	Webster	NY		
Kaplan; Samuel	Walworth	NY		
Haack; John L.	Pittsford	NY		
Renfer; Dale S.	Webster	NY		
Smith; Thomas W.	Penfield	NY		
Donaldson; Janaia M.	Nevada City	CA		
Mallgren; William R.	Nevada City	CA		
Wilson; James S.	Long Beach	CA		

US-CL-CURRENT: 703/2

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC | Draw Desc | Image

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☐ 5. Document ID: US 5379234 A

L7: Entry 5 of 7 File: USPT Jan 3, 1995

US-PAT-NO: 5379234
DOCUMENT-IDENTIFIER: US 5379234 A

TITLE: Computer-aided chemical illustration system

DATE-ISSUED: January 3, 1995

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Wilson; James S.	Long Beach	CA		
Mallgren; William R.	Portola Valley	CA		
Donaldson; Janaia M.	Portola Valley	CA		
Kaplan; Samuel	Walworth	NY		
Facci; John S.	Webster	NY		

US-CL-CURRENT: 703/11

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
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☐ 6. Document ID: US 5314778 A

L7: Entry 6 of 7 File: USPT May 24, 1994

US-PAT-NO: 5314778
DOCUMENT-IDENTIFIER: US 5314778 A

TITLE: Toner compositions containing complexed ionomeric materials

DATE-ISSUED: May 24, 1994

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Smith; Thomas W.	Penfield	NY		
Luca; David J.	Rochester	NY		
Julien; Paul C.	Webster	NY		

US-CL-CURRENT: 430/108.22; 430/108.11, 430/108.24, 430/108.3, 430/108.4, 430/109.3, 430/110.1, 430/111.34

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC
Draw Desc | Image

☐ 7. Document ID: US 5249137 A

L7: Entry 7 of 7 File: USPT Sep 28, 1993

US-PAT-NO: 5249137
DOCUMENT-IDENTIFIER: US 5249137 A

TITLE: Computer-aided chemical illustration system

DATE-ISSUED: September 28, 1993

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Wilson; James S.	Long Beach	CA		
Mallgren; William R.	Portola Valley	CA		
Donaldson; Janaia M.	Portola Valley	CA		
Kaplan; Samuel	Walworth	NY		
Facci; John S.	Webster	NY		

US-CL-CURRENT: 703/2; 345/441, 707/502, 707/514, 707/519, 707/538

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | KWIC

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Terms	Documents
L2 and (normaliz$6) and (tetrahedral or tetrahedron)	7

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Previous Page Next Page

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Help | Logout | Interrupt

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L1 and (tetrahedron or tetrahedral) same (grid point$1)	3

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L1	(normaliz$6) and @pd<19980702	34096	L1

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Search Results - Record(s) 1 through 3 of 3 returned.

☐ 1. Document ID: US 5710709 A

L3: Entry 1 of 3 File: USPT Jan 20, 1998

US-PAT-NO: 5710709
DOCUMENT-IDENTIFIER: US 5710709 A

TITLE: NC milling simulation and dimensional verification via dexel representation

DATE-ISSUED: January 20, 1998

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Oliver; James H.	Ames	IA		
Huang; Yunching	Ames	IA		

US-CL-CURRENT: 700/184; 345/781, 345/964

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

☐ 2. Document ID: US 5537520 A

L3: Entry 2 of 3 File: USPT Jul 16, 1996

US-PAT-NO: 5537520
DOCUMENT-IDENTIFIER: US 5537520 A

TITLE: Method and system for displaying a three dimensional object

DATE-ISSUED: July 16, 1996

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Doi; Akio	Machida			JPX
Koide; Akio	Kawasaki			JPX

US-CL-CURRENT: 345/422; 345/421

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

☐ 3. Document ID: US 5390035 A

L3: Entry 3 of 3 File: USPT Feb 14, 1995

US-PAT-NO: 5390035
DOCUMENT-IDENTIFIER: US 5390035 A

TITLE: Method and means for tetrahedron/octahedron packing and tetrahedron extraction for function approximation

DATE-ISSUED: February 14, 1995

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Kasson; James M.	Menlo Park	CA		
Plouffe, Jr.; Wilfred E.	San Jose	CA		

US-CL-CURRENT: 358/518; 358/523, 358/525

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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Terms	Documents
L1 and (tetrahedron or tetrahedral) same (grid point$1)	3

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Previous Page Next Page

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1 **Combined geometric transformation and illumination invariant obje recognition in RGB color images**
Paschalakis, S.; Lee, P.
Pattern Recognition, 2000. Proceedings. 15th International Conference on , Vo 2000
Page(s): 584 -587 vol.3

[Abstract] [PDF Full-Text (436 KB)] **CNF**

2 **Color texture classification by normalized color space representation**
Vertan, C.; Boujemaa, N.
Pattern Recognition, 2000. Proceedings. 15th International Conference on , Vo 2000
Page(s): 580 -583 vol.3

[Abstract] [PDF Full-Text (344 KB)] **CNF**

3 **Color illumination models for image matching and indexing**
Gros, P.
Pattern Recognition, 2000. Proceedings. 15th International Conference on , Vo 2000
Page(s): 576 -579 vol.3

[Abstract] [PDF Full-Text (560 KB)] **CNF**

4 **Detecting rotational symmetries using normalized convolution**
Johansson, B.; Knutsson, H.; Granlund, G.

Pattern Recognition, 2000. Proceedings. 15th International Conference on , Vo
2000
Page(s): 496 -500 vol.3

[Abstract] [PDF Full-Text (416 KB)] **CNF**

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5 **A normalized color difference edge detector based on quaternion representation**
Canhui Cai; Mitra, S.K.
Image Processing, 2000. Proceedings. 2000 International Conference on , Vol
2000
Page(s): 816 -819 vol.2

[Abstract] [PDF Full-Text (252 KB)] **CNF**

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6 **Detection of side-view faces in color images**
Gang Wei; Dongge Li; Sethi, I.K.
Applications of Computer Vison, 2000, Fifth IEEE Workshop on. , 2000
Page(s): 79 -84

[Abstract] [PDF Full-Text (528 KB)] **CNF**

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7 **Improving visual recognition using color normalization in digital vid applications**
Sanchez, J.M.; Binefa, X.
Multimedia and Expo, 2000. ICME 2000. 2000 IEEE International Conference
Volume: 2 , 2000
Page(s): 1187 -1190 vol.2

[Abstract] [PDF Full-Text (440 KB)] **CNF**

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8 **Active contour models: application to oral lesion detection in color i**
Hamarneh, G.; Chodorowski, A.; Gustavsson, T.
Systems, Man, and Cybernetics, 2000 IEEE International Conference on , Volu
2000
Page(s): 2458 -2463 vol.4

[Abstract] [PDF Full-Text (744 KB)] **CNF**

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9 **Face detection using multi-modal information**
Sang-Hoon Kim; Hyoung-Gon Kim
Automatic Face and Gesture Recognition, 2000. Proceedings. Fourth IEEE Inte
Conference on , 2000

Page(s): 14 -19

[Abstract] [PDF Full-Text (236 KB)] **CNF**

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10 **Comparative performance of different skin chrominance models an chrominance spaces for the automatic detection of human faces in col images**
Terrillon, J.-C.; Shirazi, M.N.; Fukamachi, H.; Akamatsu, S.
Automatic Face and Gesture Recognition, 2000. Proceedings. Fourth IEEE Inte Conference on , 2000
Page(s): 54 -61

[Abstract] [PDF Full-Text (236 KB)] **CNF**

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11 **Face recognition using wavelets and fuzzy C-means clustering**
Changyong Yoon; Jungho Park; Mignon Park
TENCON 99. Proceedings of the IEEE Region 10 Conference , Volume: 1 , 1999
Page(s): 80 -83 vol.1

[Abstract] [PDF Full-Text (280 KB)] **CNF**

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12 **Color image segmentation using local histogram and self-organizat Kohonen feature map**
You-Shen Lo; Soo-Chang Pei
Image Processing, 1999. ICIP 99. Proceedings. 1999 International Conference Volume: 3 , 1999
Page(s): 232 -235 vol.3

[Abstract] [PDF Full-Text (364 KB)] **CNF**

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13 **Moment based normalization of color images**
Lenz, R.; Linh Viet Tran; Meer, P.
Multimedia Signal Processing, 1999 IEEE 3rd Workshop on , 1999
Page(s): 103 -108

[Abstract] [PDF Full-Text (220 KB)] **CNF**

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14 **A perceptual distortion metric for digital color images**
Winkler, S.
Image Processing, 1998. ICIP 98. Proceedings. 1998 International Conference 1998
Page(s): 399 -403 vol.3

[Abstract] [PDF Full-Text (392 KB)] **CNF**

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15 **Color cluster rotation**
Paulus, D.; Csink, L.; Niemann, H.
Image Processing, 1998. ICIP 98. Proceedings. 1998 International Conference
Volume: 1 , 1998
Page(s): 161 -165 vol.1

[Abstract] [PDF Full-Text (560 KB)] **CNF**

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16 **Illumination-invariant color object recognition via compressed chro histograms of color-channel-normalized images**
Drew, M.S.; Jie Wei; Ze-Nian Li
Computer Vision, 1998. Sixth International Conference on , 1998
Page(s): 533 -540

[Abstract] [PDF Full-Text (860 KB)] **CNF**

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17 **Automatic exposure in computer graphics based on the minimum information loss principle**
Neumann, L.; Matkovic, K.; Purgathofer, W.
Computer Graphics International, 1998. Proceedings , 1998
Page(s): 666 -677

[Abstract] [PDF Full-Text (1444 KB)] **CNF**

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18 **Object oriented face detection using range and color information**
Sang-Hoon Kim; Nam-Kyu Kim; Sang Chul Ahn; Hyoung-Gon Kim
Automatic Face and Gesture Recognition, 1998. Proceedings. Third IEEE Inter
Conference on , 1998
Page(s): 76 -81

[Abstract] [PDF Full-Text (456 KB)] **CNF**

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19 **Neural network based auto tag identification system**
Prabhakaran, N.; Palakkat, M.; De-Wei Yang
Systems, Man, and Cybernetics, 1997. Computational Cybernetics and Simula
1997 IEEE International Conference on , Volume: 4 , 1997
Page(s): 3582 -3584 vol.4

[Abstract] [PDF Full-Text (280 KB)] **CNF**

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20 **Parameter estimation for linear multichannel multidimensional mod**

non-Gaussian discrete random fields
Tugnait, J.K.
Acoustics, Speech, and Signal Processing, 1997. ICASSP-97., 1997 IEEE Inter
Conference on , Volume: 4 , 1997
Page(s): 3029 -3032 vol.4

[Abstract] [PDF Full-Text (304 KB)] **CNF**

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21 **Color image normalization through illuminant recovery**
Lenz, R.; Meer, P.
Acoustics, Speech, and Signal Processing, 1997. ICASSP-97., 1997 IEEE Inter
Conference on , Volume: 4 , 1997
Page(s): 3141 -3144 vol.4

[Abstract] [PDF Full-Text (272 KB)] **CNF**

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22 **Adaptive methods for dithering color images**
Akarun, L.; Yardunci, Y.; Cetin, A.E.
Image Processing, IEEE Transactions on , Volume: 6 Issue: 7 , July 1997
Page(s): 950 -955

[Abstract] [PDF Full-Text (160 KB)] **JNL**

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23 **Segmenting color images using normalized deviation body reflecta**
Lifeng Liu; Guangyou Xu
Systems, Man and Cybernetics, 1996., IEEE International Conference on , Vol
1996
Page(s): 487 -492 vol.1

[Abstract] [PDF Full-Text (600 KB)] **CNF**

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24 **Multichannel adaptive L-filters in color image filtering**
Kotropoulos, C.; Pitas, I.; Gabrani, M.
Image Processing, 1996. Proceedings., International Conference on , Volume:
Page(s): 989 -992 vol.1

[Abstract] [PDF Full-Text (520 KB)] **CNF**

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25 **Adaptive methods for dithering color images**
Akarun, L.; Yardimci, Y.; Enis Cetin, A.
Image Processing, 1995. Proceedings., International Conference on , Volume:
Page(s): 125 -128 vol.3

[Abstract] [PDF Full-Text (428 KB)] **CNF**

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26 **Segmenting images using normalized color**
Healey, G.
Systems, Man and Cybernetics, IEEE Transactions on , Volume: 22 Issue: 1 , 1992
Page(s): 64 -73

[Abstract] [PDF Full-Text (1172 KB)] **JNL**

27 **Self-organizing neural networks for unsupervised pattern recogniti**
Kim, D.S.; Huntsberger, T.L.
Computers and Communications, 1991. Conference Proceedings., Tenth Annu International Phoenix Conference on , 1991
Page(s): 39 -45

[Abstract] [PDF Full-Text (484 KB)] **CNF**

28 **A color metric for computer vision**
Healey, G.; Binford, T.O.
Computer Vision and Pattern Recognition, 1988. Proceedings CVPR '88., Com Society Conference on , 1988
Page(s): 10 -17

[Abstract] [PDF Full-Text (520 KB)] **CNF**

[Prev] 1 2